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(54) IMPROVEMENTS IN AND RELATING TO INSULATING MATERIALS

(71) We, VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY INSTITUT ELECTROMASHINOSTROENIA, D-41, Leningrad, U.S.S.R., a Corporation organised and existing under the laws of the U.S.S.R., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical insulating materials.

According to the present invention there is provided an electrical insulating material comprising a glass fibre fabric varnished with a composition comprising an escapon compound and bonded with a bonding agent to a mica material, the varnish of the varnished fabric containing an organosilicon compound in an amount of up to 30% by weight of the varnish, the bonding agent comprising a mixture of a liquid synthetic rubber, a butylphenol/formaldehyde resin and a mineral or vegetable oil, the bonding agent being present in an amount of from 5 to 30 per cent by weight of the insulating material.

The term "escapon" is used in the art to refer to electrically-insulating synthetic rubbers which are prepared by heating unvulcanised synthetic rubbers (e.g. butadiene rubbers), for example at 250° to 300°C, without a vulcanising agent, and in the presence or absence of air.

Electrical insulating materials in accordance with the invention generally have high elasticity, resistance to corona-discharge, and good heat conductivity. Typically they can withstand temperatures of up to 155°C for lengthy periods. They also show good workability and provide a continuity of insulating coating which is particularly good where sticky tapes are used. With continuous insulation, vacuum or hydrostatic pressing is not required since gaseous products are not evolved when the bonding agents harden.

The insulating materials have also been found to be stable against the elements in tropical climates. They are also generally convenient to handle and can be used in insulating low-voltage electrical machines. Materials in the form of sticky tapes can be stored, for example, for six months without deterioration of their properties or workability. If the materials are stored without a sticky layer, this storage period can be extended to more than two years without any substantial detrimental effect upon the main properties of the materials.

Insulating materials in accordance with the invention can be produced by first applying a varnish film to a glass fibre fabric in an amount of from 10 to 30 per cent by weight of the fabric. The varnish film preferably consists of a mixture of a synthetic rubber, an escapon compound based on oligomers of butadiene, and a mineral or vegetable oil, the mixture being dissolved in divinylbenzene, styrene, methyl methacrylate, a liquid escapon based on oligomers of butadiene, or kerosene. The varnish film is modified by the addition of a liquid hydrophobic organosilicon compound which is used in an amount of up to 30 per cent by weight of the varnish. The following is a typical composition for a varnish for producing an insulated material in accordance with the invention, all parts being by weight.

Synthetic rubber (sodium catalysed butadiene polymer)	100 parts
Escapon compound	100 parts

[Price 33p]

Oil (aviation grade)	100 parts
Factice of linseed oil	10 parts
Phenyl-β-naphththylamine	6 parts
Lead resinate	6 parts
Water-repellant fluid (polyethylhydrosiloxane or polyphenylhydrosiloxane)	10–60 parts

The varnish can be applied to the glass fabric, for example by dipping, spraying or brushing, and the fabric then heated at a temperature of 150° to 300°C until an elastic layer in a tack-free condition is formed. The presence in the film of an organosilicon compound increases the waterproofness of the treated fabric, its resistance to corona-discharge along its surface, and its stability to high temperatures.

A layer of a bonding agent is then applied to the fabric. This agent is a mixture of a liquid synthetic rubber, a butylphenol-formaldehyde resin and a mineral or vegetable oil, with or without a polymerization accelerator.

The following compositions are examples of bonding agents which may be used. All parts are by weight.

Example 1

Liquid synthetic rubber	30–40 parts
Butylphenol/formaldehyde resin	40–30 parts
Castor Oil (dehydrated)	30–35 parts

Example 2

Liquid synthetic rubber	30–40 parts
Butylphenol/formaldehyde resin	40–30 parts
Linseed oil	30 parts

Example 3

Liquid synthetic rubber	20–25 parts
Butylphenol/formaldehyde resin	25–20 parts
Linseed oil	20–25 parts
Oil (aviation)	20–25 parts
Lead resinate	2–2.5 parts
Calcium resinate	2–2.5 parts

Styrene, divinylstyrene or methyl methacrylate can be added to these compositions to decrease their viscosities. The bonding agent can be applied by dipping, brushing or spraying.

Mica, preferably in the form of a paper, for example, 0.02 to 0.06 mm thick, is applied to one or both sides of the sticky layer of bonding agent on the glass fabric, and the resulting assembly can be rolled on hot calenders with subsequent treatment at a temperature of 100° to 200°C until a solid, elastic material is formed. The heat treatment is preferably continued for 0.2 to 5 hours. The resultant product is a flexible, electrical insulating material in accordance with the invention, containing the bonding agent in an amount of from 5 to 30 per cent by weight of the insulation material.

A few examples of electrical insulating materials in accordance with the invention are given below. All parts are by weight.

Example 4

Escapon glass fabric	50 parts
Micanite paper	45 parts
Bonding agent	5 parts

Example 5

Escapon glass fabric	40 parts
Micanite paper	45 parts
Bonding agent	15 parts

Example 6

Escapon glass fabric	25 parts
Micanite paper	45 parts
Bonding agent	30 parts

The electrical insulating materials produced had dielectric strengths of not less than 40–50 kV/mm, both in the initial state, and after rolling with a 2 kg. roller. The elasticity of the insulating material accounts for its high workability. The thermal conductivity of the materials was 0.40 W/m°C.

Owing to increased resistance to heat and corona-discharge along their surfaces, and their high thermal conductivities, insulating materials in accordance with the invention can be used for insulating connecting wires, buses, electric machines, for example coils thereof, armatures, pole coils, and many other parts and units.

In many applications, the insulating materials are required to be sticky. This can be achieved by applying a layer of a sticky composition to the surface of insulating materials in accordance with the invention. The sticky composition can be a mixture of a synthetic rubber, a waste material from a synthetic rubber polymerization process, a vegetable oil, an epoxy resin, a phenol formaldehyde resin and a hardener. The sticky composition is preferably applied to the insulating material in amount of from 5 to 30 per cent by weight of the insulating material.

The following are examples of sticky compositions. All parts are by weight.

Example 7

Liquid synthetic rubber	10–15 parts
Butylphenol/formaldehyde resin	25–30 parts
Linseed oil	30–25 parts
Oil (aviation)	30–25 parts
Lead resinate	2.5–3.0 parts
Calcium resinate	2.5–3.0 parts

Example 8

Liquid synthetic rubber	22–25 parts
Butylphenol/formaldehyde resin	25–22 parts
Epoxy resin	1–2 parts
Linseed oil	22–25 parts
Oil (aviation)	25–22 parts
Lead resinate	2.4 parts
Calcium resinate	2.4 parts

Example 9

Liquid synthetic rubber	10 parts
Phenol/formaldehyde resin	10 parts
Epoxy resin	35.5 parts

5-Methylbicyco [2,2,1] hept-5-ene-2,3- dicarboxylic acid anhydride	28.5 parts
Linseed oil	16 parts

Example 10

Liquid synthetic rubber	5.5 parts
Butylphenol/formaldehyde resin	11 parts
Linseed oil	11 parts
Polydienes (waste from synthetic rubber production)	44 parts
Oil (aviation)	22 parts
Lead resinate	0.6 parts
Calcium resinate	0.6 parts

Mixtures of the above ingredients were vacuum degassed at a temperature of 40–50°C in the presence of a catalyst. The resulting mixtures were applied in even layers to electrical insulating materials in accordance with the invention by dipping, spraying or brushing.

When stored in rolls, the sticky insulating materials retained their elasticity and sticky properties, and the varnish film and micanite paper were not softened, but remained solid. The tensile strengths of the materials were 8 kg/sq.mm., and their dielectric strengths were up to 50 kV/mm.

Continuity of insulation can be obtained by winding a layer of the insulation material on the article to be insulated and heating at a temperature of 100° to 200°C until the material hardens, the use of pressure vessels not being required.

It is preferred to use oligomers of butadiene, polydienes or monomers, such as styrene, divinylstyrene, methyl methacrylate, liquid escapon or other monomers containing free double bonds, as the waste materials from synthetic rubber production.

In order to increase the mechanical strength and workability of the insulation with sticky insulating materials, it is possible to use a composite material having a dielectric insulating material on at least one of its surfaces, the insulating material having the following composition, for example, all parts being by weight:

Escapon glass fabric	25–22 parts
Micanite paper	45–40 parts
Binder	25–30 parts
Dielectric insulating material	5–8 parts

The dielectric insulating materials can, for example, be films of polyethylene terephthalate, polyethylene, polytetrafluoroethylene, a cellulose polyacetate e.g. cellulose triacetate, or a polycarbonate.

The dielectric insulating material is applied to the sticky layer on the insulating material, after which the composite material is preferably treated at a temperature of from 100° to 200°C.

This material can also be used for insulating housings and as an interphase insulation in low-voltage d.c. machines.

WHAT WE CLAIM IS:—

1. An electrical insulating material comprising a glass fibre fabric varnished with a composition comprising an escapon compound and bonded with a bonding agent to a mica material, the varnish of the varnished fabric containing an organosilicon compound in an amount of up to 30% by weight of the varnish, the bonding agent comprising a mixture of a liquid synthetic rubber, a butylphenol/formaldehyde resin and a mineral or vegetable oil, the bonding agent being present in an amount of from 5 to 30 per cent by weight of the insulating material.

2. An electrical insulating materital as claimed in Claim 1, having a sticky layer on a surface thereof, said layer comprising a mixture of a synthetic rubber, a waste material from a synthetic rubber polymerization process, a vegetable oil, an epoxy resin, a phenol/formaldehyde resin and a hardener, and being present in amount from 5 to 30 per cent by weight of the insulating material.

3. An electrical insulating material as claimed in Claim 2, wherein the waste material comprises a polydiene, styrene or methyl methacrylate.

4. An electrical insulating material as claimed in any of the preceding Claims, having a dielectric insulating material on a surface thereof.

5. An electrical insulating material as claimed in Claim 4, wherein the dielectric insulating material comprises a film of polyethylene, polytetrafluoroethylene, cellulose triacetate, polyethylene terephthalate, or a polycarbonate.

6. An electrical insulating material as claimed in Claim 1, and substantially as herein described.

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